PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B05B 7/12, 7/10 — A1

(11) International Publication Number: WO 94/13404

(43) International Publication Date: 23 June 1994 (23.06.94)

(21) International Application Number: PCT/GB93/02531

(22) International Filing Date: 10 December 1993 (10.12.93)

(30) Priority Data:

9225944.9	11 December 1992 (11.12.92)	GB
9317678.2	25 August 1993 (25.08.93)	GB

(71) Applicant *(for all designated States except US)*: ROBINSON, Jeffrey, Vincent [GB/GB]; 1 The Green, Westlode Street, Spalding, Lincs PE11 2AG (GB).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: ROBINSON, George, Walter [GB/GB]; 56 Sherwood Drive, Spalding, Lincs PE11 1QP (GB).

(74) Agent: ARCHER, Philip, Bruce; Urquhart-Dykes & Lord, New Priestgate House, 57 Priestgate, Peterborough, Cambridgeshire PE1 1JX (GB).

(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

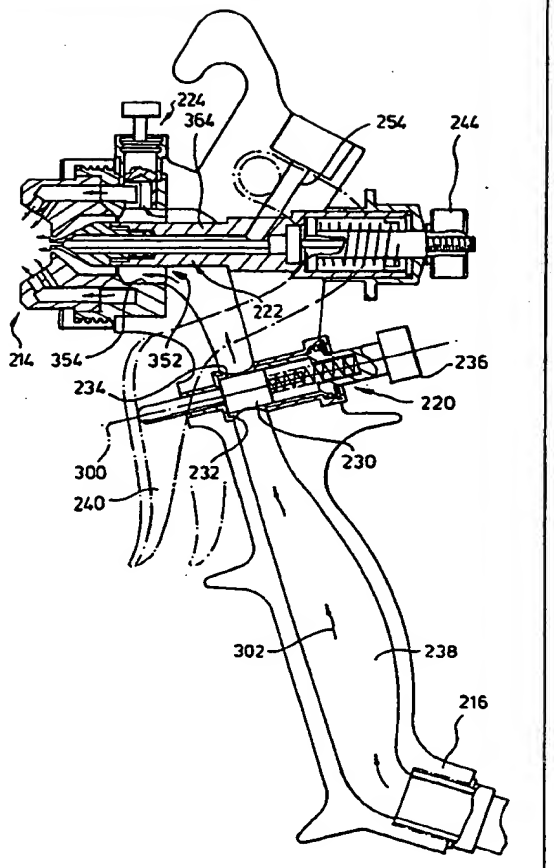
Published

With international search report.

(54) Title: METHOD AND APPARATUS FOR SPRAYING

(57) Abstract

Low pressure paint spraying apparatus comprises a substantially uninterrupted large diameter through-flow air conduit (302) to the spray nozzle. Trigger actuation of the needle valve (222) controlling the nozzle (214) is via an external sliding collar permitting connection to the valve stem rearwardly of the portion of it passing through the air passage (302). Vortex production means in the air passage enhances air velocity within the apparatus. An air-control sleeve valve (234) independently regulates the effective opening over which a trigger-operated piston valve (230) operates.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**GB**	United Kingdom	**MR**	Mauritania
AU	Australia	**GE**	Georgia	**MW**	Malawi
BB	Barbados	**GN**	Guinea	**NE**	Niger
BE	Belgium	**GR**	Greece	**NL**	Netherlands
BF	Burkina Faso	**HU**	Hungary	**NO**	Norway
BG	Bulgaria	**IE**	Ireland	**NZ**	New Zealand
BJ	Benin	**IT**	Italy	**PL**	Poland
BR	Brazil	**JP**	Japan	**PT**	Portugal
BY	Belarus	**KE**	Kenya	**RO**	Romania
CA	Canada	**KG**	Kyrgystan	**RU**	Russian Federation
CF	Central African Republic	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CG	Congo			**SE**	Sweden
CH	Switzerland	**KR**	Republic of Korea	**SI**	Slovenia
CI	Côte d'Ivoire	**KZ**	Kazakhstan	**SK**	Slovakia
CM	Cameroon	**LI**	Liechtenstein	**SN**	Senegal
CN	China	**LK**	Sri Lanka	**TD**	Chad
CS	Czechoslovakia	**LU**	Luxembourg	**TG**	Togo
CZ	Czech Republic	**LV**	Latvia	**TJ**	Tajikistan
DE	Germany	**MC**	Monaco	**TT**	Trinidad and Tobago
DK	Denmark	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**US**	United States of America
FI	Finland	**ML**	Mali	**UZ**	Uzbekistan
FR	France	**MN**	Mongolia	**VN**	Viet Nam
GA	Gabon				

METHOD AND APPARATUS FOR SPRAYING

This invention relates to a method and apparatus for spraying. Particularly, but not exclusively, the invention is applicable to spray guns for the application of paint, and like material surface treatments, for example in the motor vehicle industry.

In the past, spray guns have used air pressures between 40 and 90 psi, and these high pressures cause a cushion of air to be formed on the surface of the product being treated. This cushion causes some of the sprayed material to bounce back and to be lost in the surrounding air.

Accordingly, this type of spray gun is very inefficient. Rarely are transfer efficiencies greater than 40%, and the waste of paint material also produces unacceptable emission of volatile organic compounds. These can be highly toxic and damaging to the atmosphere.

To overcome these problems it is necessary to reduce the air pressure used in such guns. If the air pressure is reduced on a spray gun designed for high pressure use, the turbulence and restrictions in internal air passages, and in the air cap, cause a loss of air speed and a reduction in air volume. The result of this is low paint transfer rates, poor atomisation and an inferior paint finish. Transfer efficiency is however improved.

Existing high pressure spray guns have been modified to operate at low pressures, but the complexity of the designs and the intricate interconnecting drilled passages do not permit good air flow. The considerable and complex machining of the body and the need for a large number of components cause the unit costs to be high.

More specifically, in prior spray guns the means for actuating the valves which control and regulate the flow of liquid materials to be sprayed, and the pressurised air supply, and the interaction of these controls with the air flow passages to the spray nozzle, and the disposition of the

significant restrictions in the air flow path.

Likewise, in order to provide a convenient means for actuating the stem of the air flow needle valve, the main nozzle of the apparatus is mounted on a forward projection of the apparatus so as to leave a free space to accommodate the arc of movement of the valve control trigger.

A further specific factor in prior proposals relates to the use of poppet-type valves to control the air flow to the nozzle. Such a valve does not provide variable opening characteristics, but has a more nearly open or closed operating pattern which introduces significant limitations in the performance of the apparatus. Moreover, since the same trigger operates both the liquid and air control valves, the on/off operating characteristics of the air control valve can lead to difficulties in certain operating conditions where the liquid control valve has been manually adjusted to a point which affects the ability of the trigger to operate both valves simultaneously.

An object of the present invention is to provide a method and apparatus for spraying paint and other surface treatment liquids offering improvements in relation to one or more of the matters discussed above, or generally.

According to the invention there is provided a method and apparatus for spraying as defined in the accompanying claims.

In an embodiment there is provided a connection from the operating member of the spray apparatus, such as a trigger, to the stem or like structure of the liquid control valve, for example a needle valve, in which the stem is connected to the trigger at a rearward region of the stem.

In a preferred embodiment, the trigger is connected to the rearward region of the stem of the needle valve through

a sleeve member sliding on a rearward portion of the housing of the apparatus, through which the stem of the needle valve extends. The trigger is connected to the sleeve by simply abutting a flange at the forward end of the sleeve. In this way, operating thrust is applied to the needle valve in a direct and simple way. The relatively slim valve stem extends through the main air passage, without effecting any significant throttling thereof. Because the trigger and its connection to the valve stem are located at the exterior of the housing, no space is needed within the housing to accommodate these components, and the spray nozzle can be mounted directly on the main body of the spray head, thereby considerably shortening the lengthwise extent thereof.

In accordance with another aspect of the invention, an embodiment provides an air control valve comprising an axially sliding piston to effect progressive throttling of the air flow. There is provided in addition to the piston a sleeve valve comprising a rotatable sleeve member permitting manual adjustment of the effective dimensions of the through flow air passage, thereby to modulate further the air flow characteristics. The stem of the valve control piston is connected to the operating trigger of the apparatus. Whatever the setting of the sleeve valve, a complete range of axial movement of the piston is available to throttle the available air flow.

In preferred embodiments of the invention described below, there is provided a single air passage of large cross-sectional area which can be cast or drilled into the body of the housing. There are no interconnecting air passages. The trigger-operated air control valve is a double sleeve and piston valve and passes across the single air passage. By rotating the inner sleeve of the valve, the total volume of air can be controlled, while movement of the piston of the valve uncovers the ports of the valve permitting the passage of air.

The needle valve controlling the flow of material to be

air passage thereby. Moreover, the air cap and material nozzle are profiled to maintain maximum air speed.

In this way, the large single air passage permits the transfer of large volumes of low pressure air at near maximum possible air speed. The machining of the body or housing of the apparatus is simplified, and the number of components is considerably reduced. Also, material transfer rates are equal to or exceed those of high pressure guns. Material transfer efficiency exceeds that of high pressure guns, and those of guns modified to operate at low pressure. The maintenance of high air speeds improves material pick-up and atomisation.

In the above-discussed embodiments I have disclosed a method and apparatus whereby the flow of air to the nozzle in a relatively low pressure spray gun system can be improved by the use of large open air passageways, preferably a single air passage of large cross-sectional area, as compared with the corresponding passages in conventional high pressure spray guns. I have disclosed apparatus whereby the control of the spray gun apparatus no longer needs to interfere with the free flow of air through the apparatus to the nozzle.

In accordance with a further aspect of the invention I have established that while this free flow of air is of undoubted importance, its benefits can be further enhanced by the provision of additional means to improve the spray performance of the appartaus without the need significantly to increase the air flow rate.

According, an object of this aspect of the present invention is to provide a method and apparatus whereby spray gun performance is enhanced at relatively low air flow rates, and/or means whereby the depression or vacuum applied to the material to be sprayed is significantly increased without the attendant disadvantages of conventional high flow rate spray guns, and/or improvements generally in such method and apparatus.

In accordance with this aspect of the present invention there is provided an embodiment applicable to spray gunds for the application of paint and like material surface treatments, for example in the motor vehicle industry. In the embodiment, vortex production means is provided and is adapted and employed to produce air vortices within the apparatus.

In use it is found that the production of such air vortices enables relatively high depressions (or reductions in atmospheric pressure) to be applied to a meterial to be sprayed, at relatively low air flow reates. Thus, for example, normal high volume paint spray guns produce a depression of 25 to 64 millimetres (one to 2.5 inches) water gauge at the liquid paint material inlet port, and average low pressure spray guns ofter produce no depression at all and thus there is a requirement to pressurise the paint tank. It has been found possible by means of the apparatus disclosed herein, employing vortex production means to obtain a corresponding depression of about 89 mm (3.5 inches) water gauge, and it is expected that depressions of up to 305 mm (12 inches) water gauge may be obtainable in a similar way.

In an embodiment, the vortex effect is produced by valve means, for example a sleeve valve. The sleeve valve is preferably suitably inclined with respect to the main direction of air flow. It is found that the vortex effect can be increased by reducing the opeing of the air control valve and increasing the inlet pressure applied to the spray gun from its air supply, whereby the overall air throughput is largely unaffected.

It is thought that the vortex effect has the result that the circulatory movement of the air within the apparatus, in vortices, effectively produces and permits a higher air speed within the apparatus than could possibly be obtained by a linear flow of the air at the low air flow rates in question.

A further enhancement of the vortex effect is thought to be produced by the provision of the relatively large air passageway in which the vortex effect can be produced. The

combination of vortex means and a relatively large cross-sectional air passage through the apparatus from the region of the air inlet to the region of the nozzle enables significant improvements in performance to be obtained.

A further broad aspect of the invention provides, per se, a single air passageway of relatively large cross-sectional area (as compared with the corresponding passageways of high pressure and high air flow rate spray guns), extending from the region of the air inlet of the apparatus to the nozzle region thereof. Even in the absence of vortex production means, such provision offers significant advantages. In combination with the vortex effect, the results are as indciated above.

The vortex production means may comprise a valve, for example a sleeve valve, or alternative aerodynamic means may be provided, for example a suitably profiled element to produce the so-called "wing-tip" effect. Thus, for example, vane means may be provided, and is disclosed in the described embodiment.

The vortex means may be located in the handle region of the apparatus, or indeed in the nozzle regoin thereof, as likewise disclosed below.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which :-

Fig 1 shows a section through a spray gun having pressure feed;

Fig 2 shows the gun of Fig 1 in unsectioned form;

Fig 3 shows, in a sectional view similar to that of Fig 1, an embodiment having gravity feed;

Fig 4 shows, in a view similar to that of Fig 2, the embodiment of Fig 3 in external view;

Fig 5 shows a cross-sectional view of the same kind as the views of Figs 1 to 4, of a further embodiment; and

Figs 6 and 7 show perspective views of two alternative vortex production means for incorporation into the apparatus

of Fig 5.

As shown in Figs 1 and 2 of the drawings, spray apparatus 10 comprises a body or housing 12 having a nozzle 14, an air supply connection 16, a reservoir 18 containing paint or like material to be sprayed, an air control valve 20, and a liquid control valve 22. A poppet valve 24 controls the supply of air to nozzle 14 in order to regulate the spray pattern.

Body 12 is manufactured from a cast or forged metal alloy, or is moulded from a thermosetting or thermoplastic polymer.

Nozzle 14 is retained by a screw-threaded ring on housing 12 and provides a central jet 26 controlled by liquid control valve 22, and an annular air jet 28 controlled by poppet valve 24, to regulate the spray pattern.

Air supply connection 16 is coupled to the usual compressor (not shown) for such applications. Reservoir 18, containing paint or like material to be sprayed, is likewise of conventional form.

Air control valve 20 comprises an axially-sliding piston 30 to effect progressive throttling of the air flow. Associated with the piston is a sleeve valve 32 comprising a rotatable sleeve member 34 permitting manual adjustment by means of a screw head 36, of the effective dimensions of the through-flow air passage 38 at that location, thereby to modulate the air flow characteristics. The stem of piston 30 is connected to an operating trigger 40 of apparatus 10. Whatever the setting of the sleeve valve 32, a complete range of axial movement of piston 30 is available to throttle the available air flow.

Liquid control valve 22 comprises a needle valve member 42 having a manual fine-adjustment nob 44 and controlled by trigger 40 through a sleeve member 46 which slides on a rearward portion 48 of housing 12. The trigger is connected to the sleeve by simply abutting a flange 50 thereon.

Poppet valve 24 has an adjustment knob 52 whereby the jet produced by central jet 26 passing through nozzle 14 is

area and has only smoothly curved changes of direction.

Air control valve 20 controls the air flow through passage 38. Sleeve member 34 and an associated second valve sleeve member, both having identical ports at 180 degrees intervals enable piston 30 to regulate air flow on a full stroke basis. A return spring (not shown) returns piston 30 to its extended position when released. Actuation of trigger 40 slides piston 30 within sleeve valve member 34 to change the degree of opening of the valve within the parameter determined by the manual setting of the sleeve valve by means of screw head 36. In the extended and rest position of the piston the valve ports are closed.

Liquid control valve 22 has the stem of needle valve member 42 screw-threadedly adjustably connected to sleeve member 46. Nob 44 provides for fine position adjustment. Trigger 40 actuates the needle member entirely externally of the housing 12, whereby no interference with air or liquid flow paths is in question. An internal return spring (not shown) spring returns the needle to its rest position.

Liquid to be sprayed is fed to needle valve 22 from reservoir 18 via a radial port 54.

Turning now to the embodiment of Figs 3 and 4, corresponding parts are numbered as in the embodiment of Figs 1 and 2, but with the reference numerals increased by 100.

The main difference from the embodiment of Figs 1 and 2 resides in the use of a gravity feed for the liquid to be sprayed. Thus, this material is delivered to the apparatus through a port 56 and a drilling 58 in housing 112. Otherwise, this embodiment is constructed and operates substantially in the same manner as the first embodiment.

In use, both embodiments operate as follows. The reservoir of material to be sprayed delivers that material to central jet 26 under the control of needle valve, 22 where it is mixed with air delivered via passage 38. The spray thus

produced is controlled by the annual air curtain produced by jet 28 under the control of poppet valve 24. The operation of the gun is initiated by trigger 40 operating air control valve 20 and liquid control valve 22.

In Fig 5, parts corresponding to those of the preceding embodiments have been identified by corresponding reference numerals in the range of 200 to 300. Not all parts have been thus-identified. This embodiment largely corresponds to the preceding ones apart from the location of the poppet valve 224 on top of the nozzle 214 and the provision of the vortex-production means as will be more fully described below. Also the paint inlet port 254 is located above rather than below the main generally horizontal axis of the main nozzle control valve.

Two vortex production means are incorporated in this embodiment in addition to the large cross-sectional area through flow air passage 238. These comprise the sleeve valve 232 and the alternative vortex production fins or vanes shown in Figs 6 and 7.

Air control valve 220 is largely constructed and arranged as described above, but it is now seen that its construction, as a sleeve valve contributes to the vortex effect within duct 238. For this purpose, the arrangement is as follows. Valve 220 has sleeve members 234 rotatable about an axis 300 to permit adjustment of the overall maximum opening permitted by piston 230 under the control of trigger 240. Sleeve valve members 234 are formed with aligned openings and can be turned about axis 300 so that the through-flow axis of the aligned openings is inclined with respect to the main direction 302 of through axial flow of air along duct 238. By turning the valve members 234 about axis 300, the through flow axis defined by the aligned openings in the valve members can be turned so as to cause the through air flow to be deflected. The degree of inclination or deflection may be in the range of 0 to 25 degrees, according to particular requirements. It is believed that the vortex effect arises

from eddies or vortices caused by narrow angle impingement of the air flow on the smooth side walls of the passage, and from the aerodynamic effect of the edges of the sleeve valve members, quite independently of such inclination.

The second vortex production means in this embodiment is shown in alternative forms in Figs 6 and 7.

In Fig 6 an annulus 350 is provided for mounting at the inlet 352 of nozzle 214 so that the annulus is seated against the inner surface of the nozzle at 354, the annulus being positioned so as not to obstruct the radial passages controlling air flow to produce the requisite spray pattern under the control of poppet valve 224.

A pair of diametrically opposed vanes or fins 356 project inwardly from annulus 350 to produce the vortex effect, as described above. The fins or vanes are inclined at 5 degrees with respect to the through flow axis of annulus 350. The range of angular inclination for the vanes may be from about 0 degrees to 25 degrees, and preferably 2.5 to 15 degrees.

Alternative vortex production elements may be provided, or in addition to those described above, preferably in the form of aerofoil sections located within the air through flow passage 238. Protrusions to achieve the same effect may possibly be of benefit provided that the through flow air passage is not significantly obstructed.

In the embodiment of Fig 7, the vortex production means comprises an annulus 360 having similar vanes or fins 362 at diametrically opposed positions on its outer surface, the annulus 360 being constructed to be mounted on the main stem 364 of liquid control valve 222.

In use, the above embodiment is employed largely as described above. Improved performance is obtained at lower air throughput rates by virtue of the vortex effects, enabling valve 220 to be allowed to reduce significantly the air throughput rate while still achieving very adequate vacuum at the inlet 254 for the paint to be sprayed.

CLAIMS :-

1 Apparatus for spraying surface treatment materials such as paint and the like, comprising :

a) an inlet for said surface treatment material;

b) an inlet for a supply of pressurised air to be mixed with said surface treatment material;

c) an outlet or nozzle for a spray of said treatment material;

d) a control valve to regulate the supply of said surface treatment material to said outlet or nozzle; and

e) actuating means for said control valve;

characterised by

f) said actuating means for said control valve being connected to said control valve at a location rearwardly with respect to the direction of spraying, whereby a stem of said control valve extends through an air passage leading from said air inlet to said outlet or nozzle without effecting significant throttling thereof.

2 Apparatus for spraying characterised by actuating means for a control valve being connected thereto without throttling the air passage to the nozzle of the apparatus.

3 Apparatus for spraying surface treatment materials such as paint and the like, comprising :

a) an inlet for said surface treatment material;

b) an inlet for supply of pressurised air to be mixed with said surface treatment material;

c) an outlet or nozzle for a spray of said treatment material;

d) a control valve to regulate the supply of said surface treatment material to said outlet or nozzle; and

characterised by

e) located in an air passage leading from said air inlet to said outlet or nozzle, structure defining vortex

production means disposed to produce air vortices within said air passage between said air inlet and said outlet or nozzle.

4 Apparatus for spraying characterised by vortex production means disposed to produce air vortices within an air passage leading to an outlet or nozzle of the apparatus.

5 Apparatus according to claim 1 characterised by said actuating means for said control valve comprising a trigger connected to a stem of said valve through a sleeve or connecting member sliding on a housing of said apparatus.

6 Apparatus according to claim 3 characterised by said vortex production means comprising valve means to control said supply of pressurised air.

7 Apparatus according to claim 6 characterised by said air valve means comprising a sleeve valve which comprises a valve member having a aligned openings, which valve member can be turned so that the through-flow axis of said aligned openings is inclined with respect to the main direction of air flow through said air passage.

8 Apparatus for spraying surface treatment materials such as paint and the like, comprising :

a) an inlet for said surface treatment material;

b) an inlet for a supply of pressurised air to be mixed with said surface treatment material;

c) an outlet or nozzle for a spray of said treatment material; and

d) a control valve to regulate the supply of said surface treatment material to said outlet or nozzle;

characterised by

e) said apparatus comprising a single air passageway of relatively large cross-sectional area (as compared with the corresponding passageways of high pressure and high air flow

rate spray guns), extending from the region of said air inlet to the region of said outlet or nozzle thereof.

9 Apparatus according to claim 5 or claim 6 or claim 7 characterised by said apparatus comprising a single air passageway of relatively large cross-sectional area (as compared with the corresponding passageways of high pressure and high air flow rate spray guns), extending from the region of said air inlet to the region of said outlet or nozzle thereof.

10 Apparatus according to claim 3 or claim 4 characterised by said vortex production means comprising an aerodynamically profiled element to produce a "wing tip" effect.

11 Apparatus according to claim 10 characterised by said profiled element comprising vane means.

12 Apparatus for spraying surface treatment materials such as paint and the like, comprising :

a) an inlet for said surface treatment material;

b) an inlet for supply of pressurised air to be mixed with said surface treatment material;

c) an outlet or nozzle for a spray of said treatment material;

d) a control valve to regulate the supply of said surface treatment material to said outlet or nozzle; and

e) valve means to control said supply of pressurised air;

characterised by

f) said valve means comprises first and second valves operable independently.

13 Apparatus according to claim 12 characterised by said first valve means being controlled by trigger means and said second valve means permitting setting of the effective dimensions of the air passage to said nozzle.

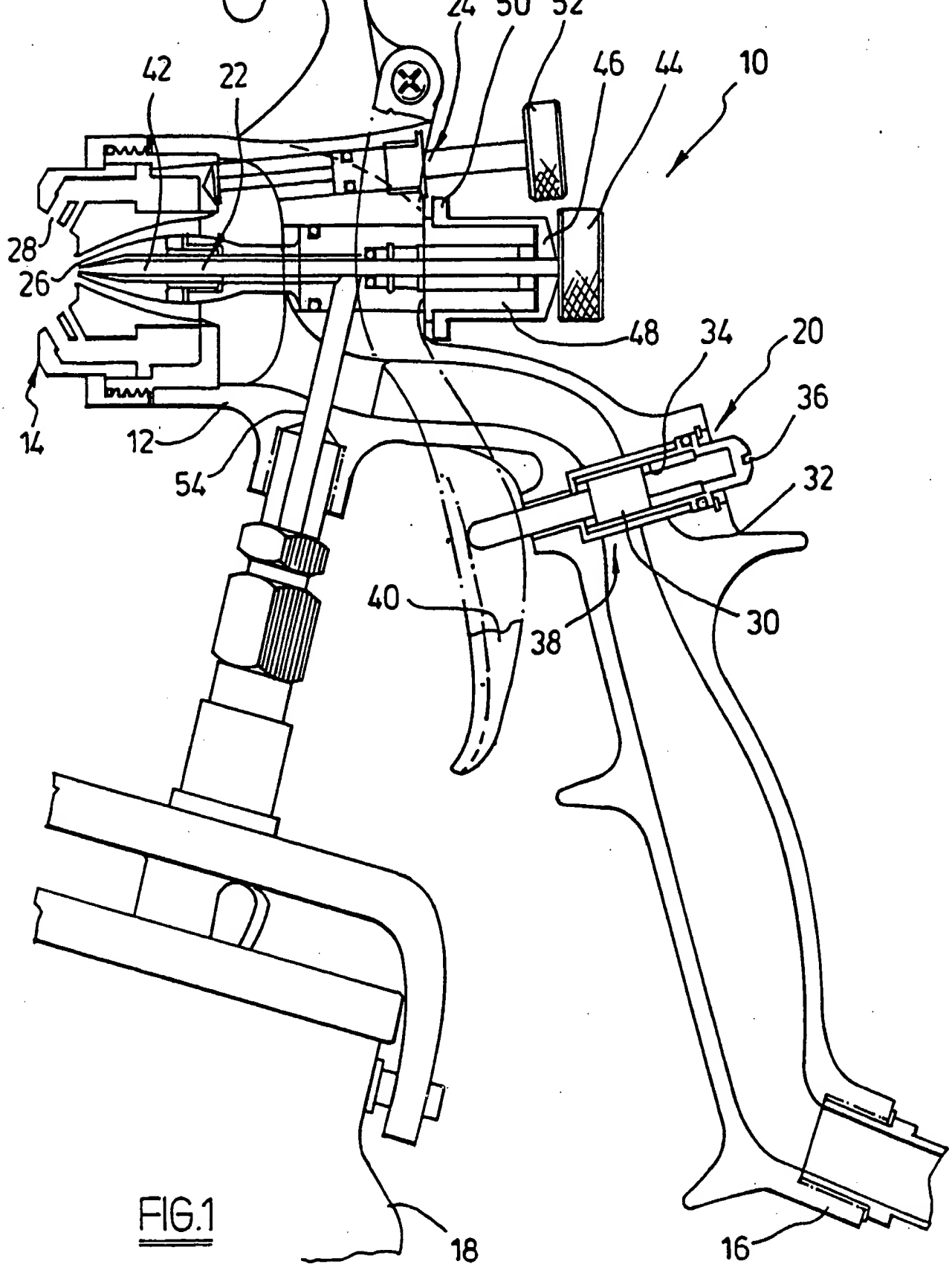


FIG.1

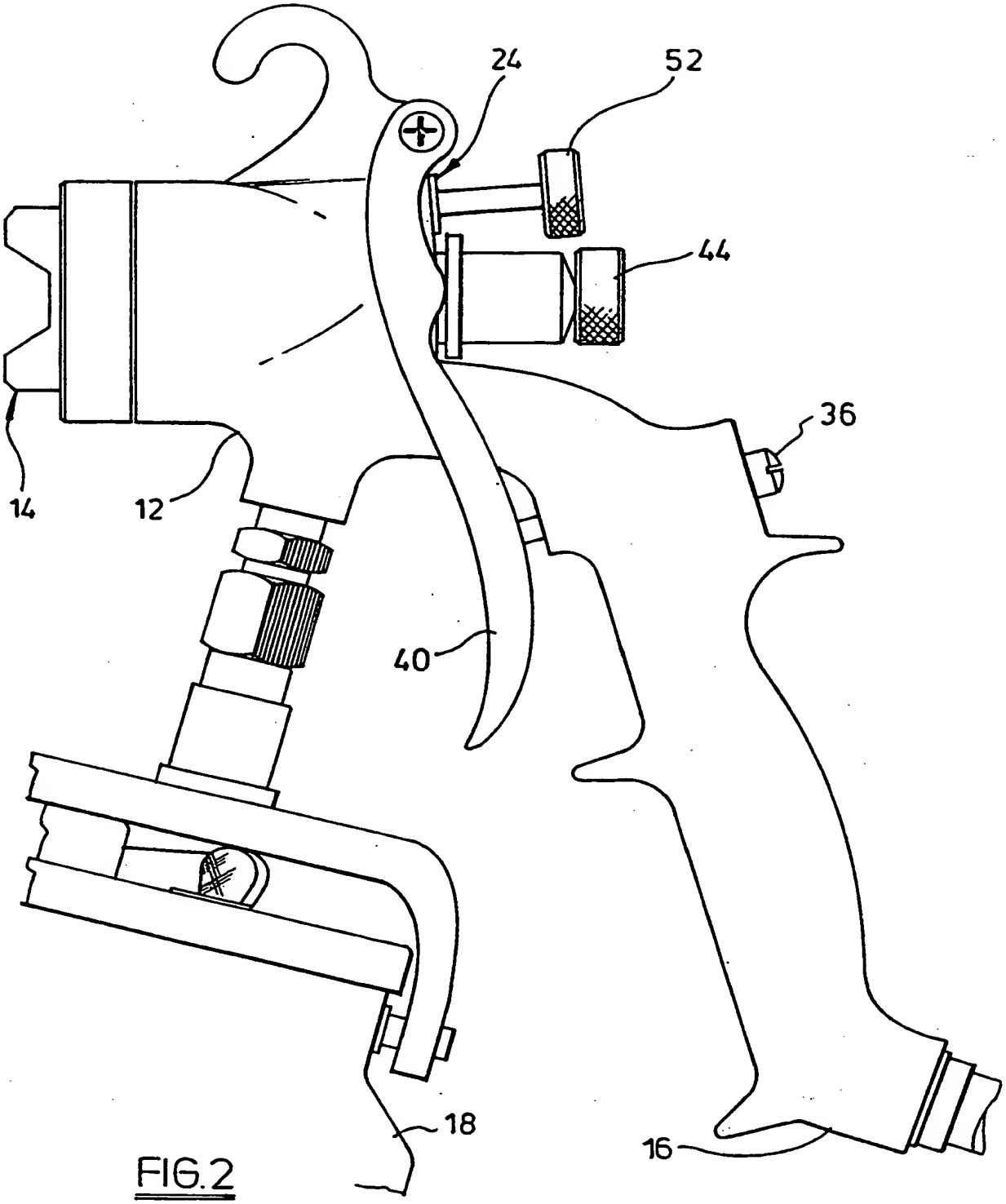


FIG.2

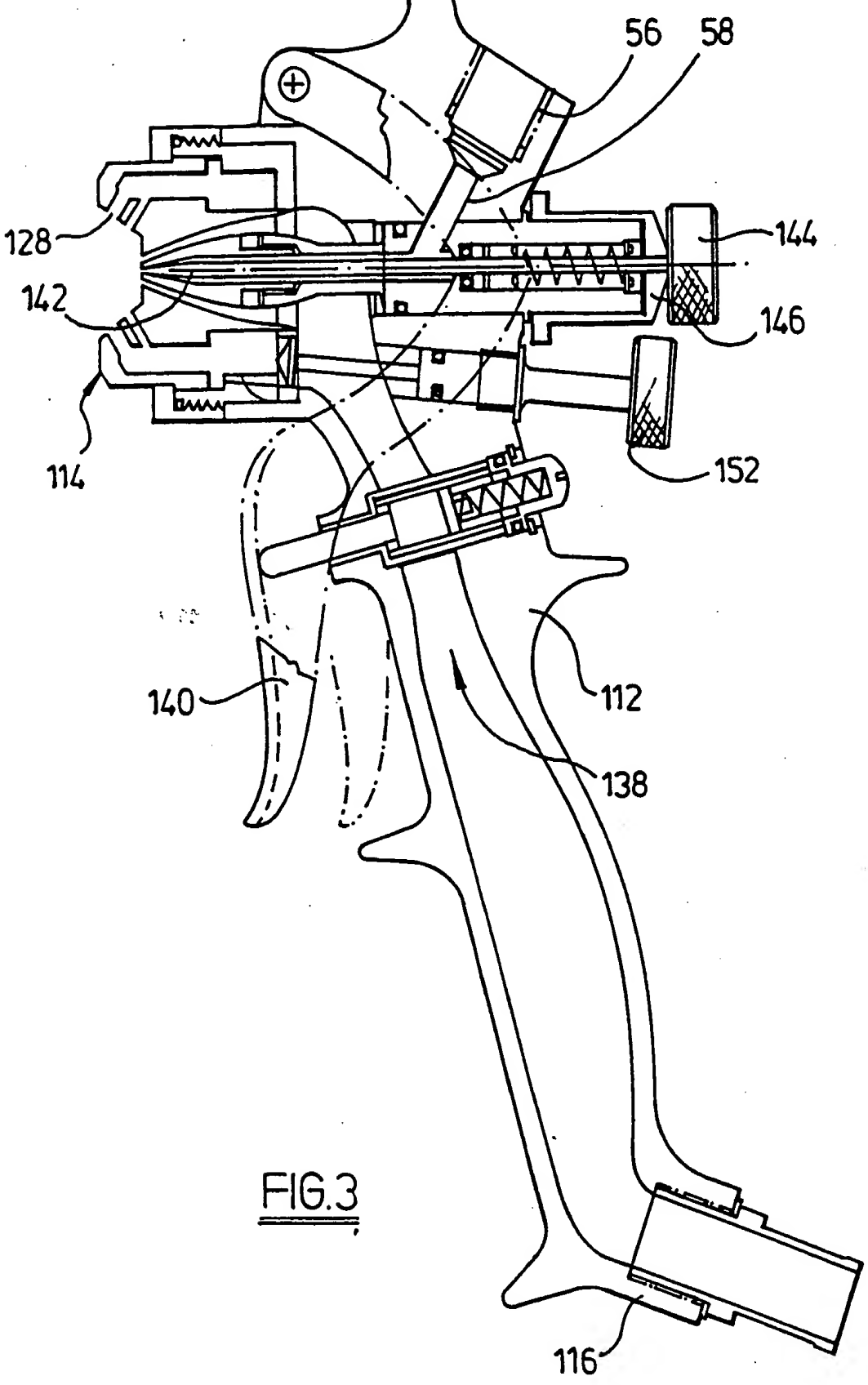


FIG.3

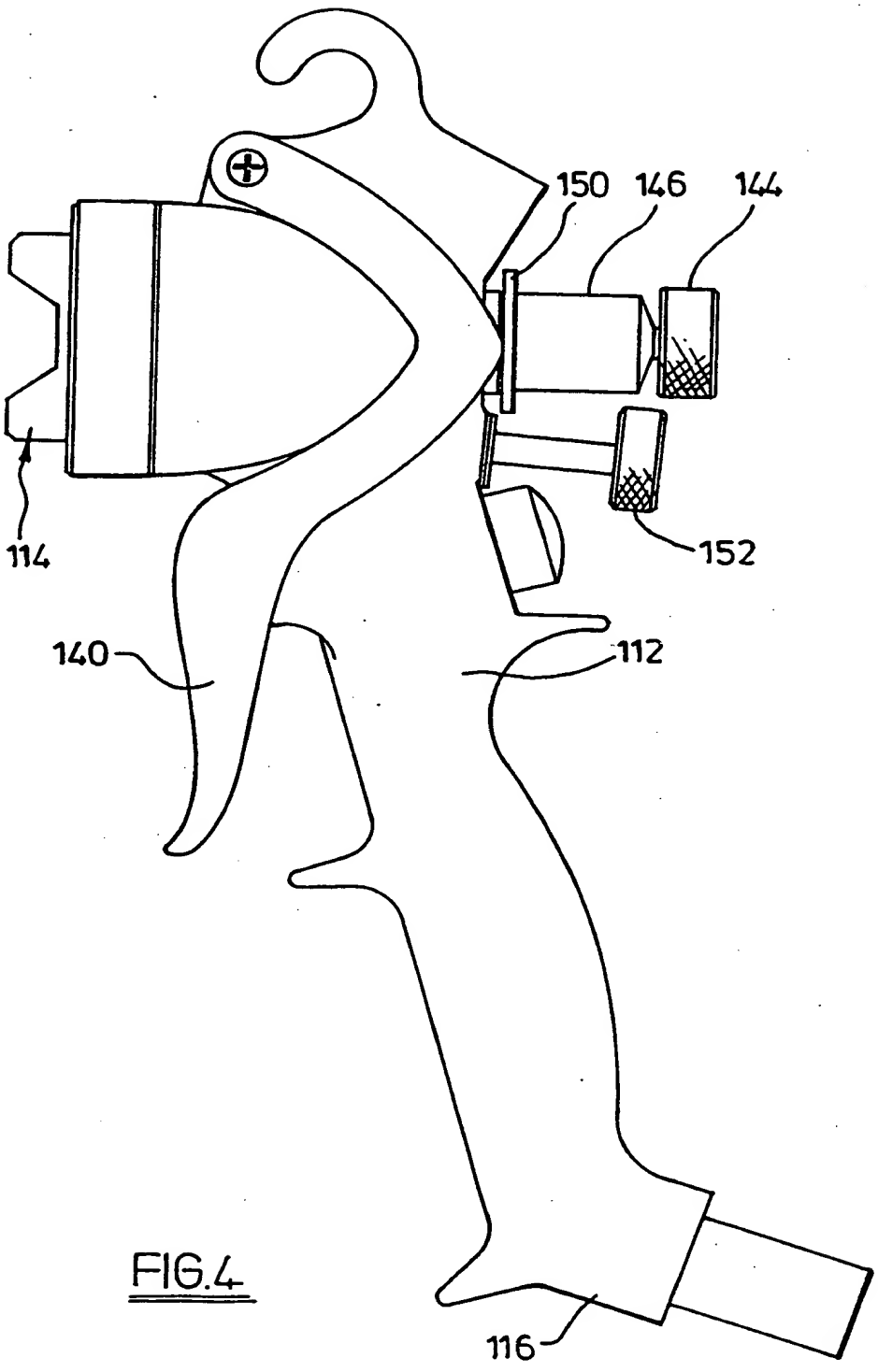


FIG.4

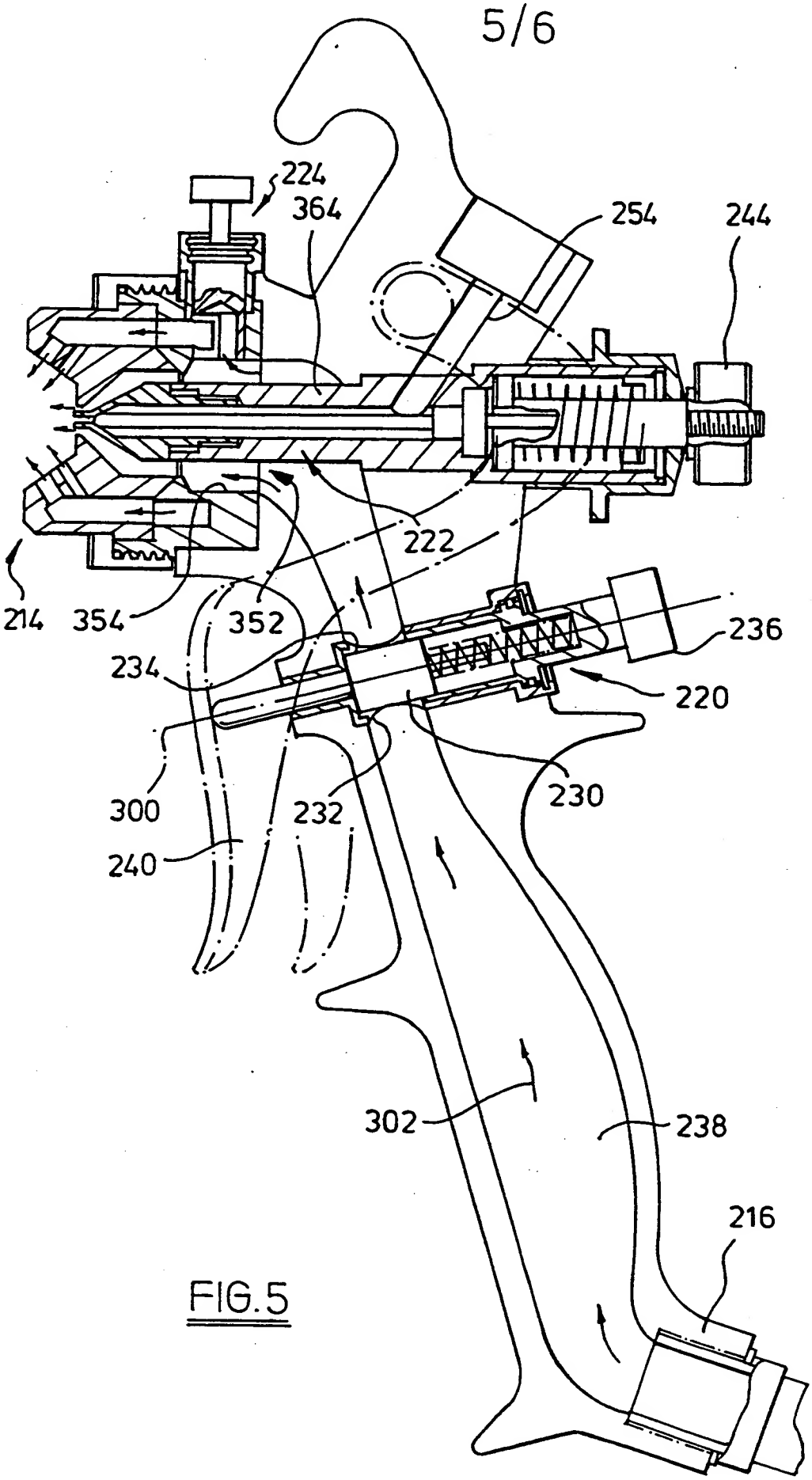

224
364
254
244
222
214
354
352
236
234
220
300
230
232
240
302
238
216

FIG.5

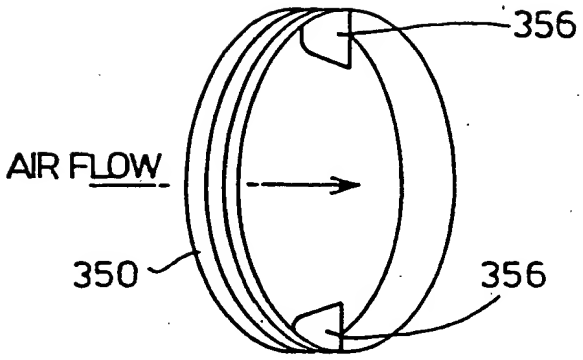


FIG.6

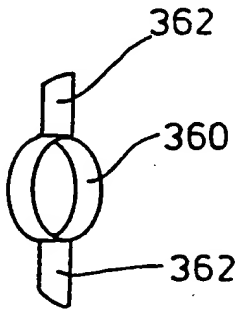


FIG.7

According to International Patent Classification (IPC) ... and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 5 B05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,B,10 47 079 (DORN) 18 December 1958 see the whole document	1,2,8
X	US,A,2 149 932 (ZIPPEL) 7 March 1939 see the whole document	1,2,8
X	FR,A,2 194 135 (S.A.M. SICMO) 22 February 1974 see the whole document	1,2,8
X	EP,A,0 427 386 (GENERAL DYNAMICS CORPORATION) 15 May 1991 see the whole document	3,4,6,9
X	DE,A,31 10 881 (SATA-FARBSPRITZTECHNIK GMBH) 11 November 1982 see the whole document	12,13

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 March 1994	4.03.94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Juguet, J

Form PCT/ISA/210 (second sheet) (July 1992)

International application No.
PCT/GB 93/02531

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO,A,90 10502 (VESI-PAULI OY) 20 September 1990 see page 4, paragraph 3	7
A	WO,A,92 17279 (BARTY) 15 October 1992 see the whole document	1,8

1

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-B-1047079		NONE		
US-A-2149932		NONE		
FR-A-2194135	22-02-74	AU-B-	468173	08-01-76
		AU-A-	4901372	23-05-74
		CA-A-	979401	09-12-75
		JP-C-	919746	22-08-78
		JP-A-	49108613	16-10-74
		JP-B-	52049848	20-12-77
EP-A-0427386	15-05-91	NONE		
DE-A-3110881	11-11-82	NONE		
WO-A-9010502	20-09-90	SE-B-	468037	26-10-92
		SE-A-	9003576	09-11-90
		US-A-	5154351	13-10-92
WO-A-9217279	15-10-92	AU-A-	1422592	02-11-92
		US-A-	5152460	06-10-92